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PUERTO RICO AGRICULTURAL EXPERIMENT STATION

MAYAGUEZ, PUERTO RICO

Under the supervision of the
UNITED STATES DEPARTMENT OF AGRICULTURE

BULLETIN No. 36

**PARASITES AND PARASITIC DISEASES
OF CATTLE IN PUERTO RICO**

By

H. L. VAN VOLKENBERG

Parasitologist



Issued October 1934



UNITED STATES DEPARTMENT OF AGRICULTURE

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PUERTO RICO AGRICULTURAL EXPERIMENT STATION, MAYAGUEZ

[Under the supervision of the Office of Experiment Stations, United States Department of Agriculture]

JAMES T. JARDINE, *Chief, Office of Experiment Stations*

STATION STAFF

H. ATHERTON LEE, *Director.*
H. L. VAN VOLKENBERG, *Parasitologist.*
R. L. DAVIS, *Agronomist.*
J. O. CARRERO, *Assistant Chemist.*
A. ARROYO, *Minor Scientific Helper.*
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A. DIAZ, *Assistant Field Aide.*
C. ALEMAR, Jr., *Principal Clerk.*

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Washington, D.C.

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By H. L. VAN VOLKENBERG, *parasitologist*

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GENERAL CHARACTERISTICS AND EFFECTS OF PARASITES

KINDS AND LOCATIONS OF PARASITES

The term parasite as used here refers to lower forms of animal life which, for the purpose of livelihood, exist on or in the bodies of the higher animals, which are known as host animals.

Parasites may be divided into three general groups: (1) Protozoa, including such groups as the hemosporidia and coccidia, the former located in the blood stream, the latter in the intestinal tract; (2) worms, including flukes, tapeworms, and roundworms, located usually in the intestinal tract, lungs, or liver, although mature worms of the various species or their larvae may invade other organs and tissues of the body; and (3) arthropods, including ticks, certain flies, lice, and mites, located usually on or in the skin.

¹The internal parasites described in this bulletin have been identified by members of the Zoological Division, Bureau of Animal Industry, and the external parasites have been identified by members of the Bureau of Entomology, U.S. Department of Agriculture. Acknowledgment is made especially of the constructive and very helpful criticism of the manuscript by Dr. Maurice C. Hall, Chief of the Zoological Division.

DAMAGE BY PARASITES

The seriousness of parasites depends on the kind or kinds and the numbers present as well as the length of time the animals are infested. Parasites may cause injury or death to the host in one or more of the following ways: (1) Loss of blood; (2) interference with digestion; (3) damage or destruction of tissue; (4) secretion or excretion of toxins which may be absorbed by the host; (5) constant irritation, itching, pain, etc.; (6) transmission of diseases directly or indirectly.

The death rate from parasitic infestations may not be high, but loss results from slow and stunted growth, uneconomical use of feed, lowered capacity for work, reduced production, and condemnation of the meat carcasses in whole or in part. A heavily parasitized animal is likely to be more susceptible to bacterial infections and other diseases, and such an animal becomes a "poor risk" when treatment is attempted with drugs and biologics.

SUSCEPTIBILITY TO PARASITES

The damage from parasites is greatest as a rule among young animals, as they seem to become more easily infested than older animals, and young tissues are more easily injured. As growth must be made in youth and cannot be made up later, it is important to pay special attention to the care of young stock.

In Puerto Rico calves suffer more from parasites than from diseases due to other causes, with the possible exception of morbid conditions caused by improper feeding. Mature cattle are injured by external parasites and protozoan diseases, but are less susceptible to the worm parasites. The liver fluke seems to be the only serious worm parasite of older cattle.

SYMPTOMS OF PARASITISM

The symptoms of parasitic worm diseases are usually less noticeable than those from infectious diseases caused by bacteria, because the onset is seldom noticeable and the symptoms are usually more vague. The presence of worm parasites may be suspected where there is a lack of growth or a loss in weight, distended abdomen, and diarrhea or constipation with little or no fever.

Anemia and edema are characteristic of the bloodsucking parasites. Anemia is shown by thinness of the blood and paleness or whitening of the mucous membranes revealed by examining the inside of the mouth and inner surface of the eyelids. Edema is a swelling caused by an accumulation of fluid in the tissues, usually in the pendent portions of the body such as underneath the jaw or in the lower abdominal region. Heavily parasitized work animals such as oxen and horses tire easily and frequently are unable to stand heavy work.

Protozoan diseases are more like specific bacterial diseases in that they usually run a more definite and acute course and show characteristic symptoms. Stockmen are more or less familiar with the arthropods or external parasites and the injuries produced by them.

LIFE HISTORY OF INTERNAL PARASITES

Protozoa multiply within the body, so that one organism may give rise to a large number of organisms. Adult worm parasites in their definite host do not multiply in the body, as a rule, as each egg or young parasite which gains entrance into the body develops usually into only one worm and multiplication depends on the eggs or young worms produced by such a parasite. As most of the mature worms live in the digestive tract or in organs in communication with the digestive tract, the eggs or young worms are passed with the feces.

It is possible, by making a microscopic examination of the fresh dung of the animal, to determine the presence of parasites and approximately the amount of infestation. The eggs or young worms as they are passed are not capable of infesting an animal, but must pass through a stage of development outside of the body, in water, soil, or manure piles, or wherever the proper conditions are found. Some species must pass a period of development in such lower animals as insects or snails. Warmth, moisture, and shade are necessary for this development on the ground. Shade for the microscopic free-living forms may be provided by any covering that conserves moisture and prevents the penetration of the direct rays of the sun.

If conditions are favorable the infective stage is reached in a few days or a few weeks. This infective stage is more resistant to unfavorable conditions than are the fresh ova or intermediate stages. The infective larvae of several species are capable of crawling up the blades of grass when these are wet with rain or dew. The host animal becomes infested by grazing or by ingesting contaminated water and green forage or by picking up the infective stages that have developed on the floors and walls of the pens or stables. Control measures are concerned with breaking this cycle of development by preventing infestations or by eliminating the worms from the host.

INFLUENCE OF CLIMATE AND TOPOGRAPHY ON PARASITES

In the temperate zones, the freezing temperatures have a very appreciable effect in limiting and destroying pasture and field infestations with parasites. In the climate of Puerto Rico there are two important limiting factors. One is a lack of moisture and another is an excess of moisture. The dry season provides a limiting factor through the lack of moisture. The southern coast, during 6 months of the year, is semiarid, and parasites do not thrive under arid conditions. The heat and drying tend to desiccate the worm eggs and larvae on the ground so that, practically speaking, pastures and fields are sterilized as far as parasites are concerned. This is unfavorable for worms as freezing temperatures elsewhere. In portions of the other coastal areas, with a few inches of rainfall distributed over a period of several months and with the amount of evaporation exceeding the precipitation, similar although less noticeable results occur over a shorter season. In those areas, such as on the western coast, where the rainfall is more evenly distributed throughout the year and where the rate of evaporation is lower, this limiting factor is less apparent.

Another limiting factor in the more humid areas during the rainy season is the torrential showers, which have a decidedly cleansing action in washing down and carrying off the source of infection, such as the eggs and larvae of parasites. This infective material is either washed into streams and destroyed or is deposited on the more level lowlands. The abundant moisture which remains after the season of heavy rains is very favorable for parasites and usually it is during this time that the heaviest infestations are obtained.

On the basis of variation in rainfall and differences in topography, Puerto Rico may be divided into three parts—the wet coastal plains of the north, east, and west; the dry southern coastal plain; and the central mountain area subject to torrential rainfall. The Isabela district on the northern coast and the island of Vieques are other dry areas, smaller but similar to the southern coast.

In general, livestock of the wet coastal plains suffer more from worm parasites than those of the other areas. The abundant moisture and the more level lands which tend to retain moisture are more favorable for the development of parasites. The southern coast area is the most favorable for raising cattle. The dry season with its destructive influence on parasites, and the rich limestone soils are very favorable, especially for young growing animals. This area appears to be especially suited as a breeding area for improved dairy cattle. However, the light and variable rains characteristic of the wet season in this area are favorable for several species of roundworms, and preventive measures and treatment are necessary. Serious infestations with roundworms among calves of this area have been especially noticeable during and following the unusual heavy rains of 1933.

The mountain areas where suitable grasses are grown are favorable for raising livestock, even though the rainfall may be very abundant. Hillsides or mountain slopes carry less infestation than bottom lands because they benefit by the cleansing action of the rain and the following run-off, as well as by holding less moisture. The benefit of the natural advantages, however, is often lost by allowing the young stock access to the stream beds and low areas.

As these differences in the climate and topography result in considerable variation in the prevalence of parasites and also some variation in the parasitic fauna, the methods used in control of parasites must vary somewhat in different parts of the island and at different times of the year.

RELATION OF PARASITES TO LIVESTOCK IMPROVEMENT IN PUERTO RICO

Stockmen and both Insular and Federal Government agencies have imported livestock of the improved breeds in order to develop better and higher producing animals. New importations and the progeny of those already introduced are replacing the native animals. The higher producing animals are very susceptible to parasites and parasitic diseases. The recommendations in regard to control of parasites are directed especially toward the animals of the improved breeds because of their rapidly increasing numbers, higher value, and need for better care and management. The same methods, however, can be used to advantage with the native stock.

GENERAL PARASITE CONTROL MEASURES

DISPOSAL OF MANURE

As manure is the direct or indirect source of most of the common parasites, its proper disposal is an important factor in control. Fresh manure or unrotted manure from an open pile, from infested animals, should not be spread on pastures or on land which is to be used for growing forage, especially the smaller grasses, unless it is plowed under. Plowing buries the eggs and larvae and apparently they do not get back to the surface in sufficient numbers to cause serious trouble. Horse manure may be spread on pastures or grass fields to be used by cattle, and vice versa. With 1 or 2 minor exceptions the internal parasites of horses are not transmissible to cattle, and horses are not susceptible to those of cattle.

A dangerous practice which is equivalent to feeding the animals from the top of a manure pile is sometimes followed. The forage is fed from piles on the ground. The left-over grass accumulates and becomes mixed with the manure. These piles retain moisture and provide favorable conditions for the larval forms of parasites. As soon as a light rain or heavy dew occurs the larvae may come to the surface and contaminate the fresh grass. The forage should always be fed from tight mangers and any left over should be disposed of with the manure.

ROLE OF FORAGE GRASSES IN PARASITE CONTROL

The roughage for livestock in Puerto Rico other than pasturage consists of soiling, usually a forage grass cut and fed in a fresh, green condition. Dried or stored roughages such as hay and silage, which carry very little if any parasitic infestation, are not used to any extent. Therefore the selection of the soiling grass is very important from a parasitological viewpoint.

The giant or rank-growing grasses such as Guatemala, elephant, and sugarcane carry very little parasitic infestation in comparison with the smaller grasses such as malojillo (Para grass) or guinea grass or other similar grasses even though fresh contaminated manure is spread on the fields in which the larger grasses are grown. As the stalks of these giant grasses grow upright and are comparatively few in number the infective eggs and larvae of parasites are less likely to be present on them.

Malojillo grass is more apt to carry these infective stages than other grasses because it grows in more direct contact with the ground and thrives only on marshy land very favorable for the development and perpetuation of parasites. Malojillo fields cannot be protected from contamination by the usual measures because infective material may be washed onto them with every fall of rain. Malojillo grass should be regarded as being unsafe to feed to calves. The cleaner giant grasses may be fed to calves, goats, and horses, but malojillo grass should be fed only to older cattle.

Guinea grass, or other small grasses grown on fields which have not been fertilized with fresh cow manure and where there is no danger of contamination by drainage from adjacent land on which infested animals are maintained, may be fed to calves without danger of infesting them with parasites.

Molasses or Yaragua grass (*Melinis minutiflora*) is another grass that may assist in parasite control. The fine hairs with which this grass is covered and its sticky exudation hinder seed ticks from climbing upon the plant and so act as a deterrent to the spread of the cattle tick.

PASTURE MANAGEMENT

Statements in regard to pastures apply principally to the dry areas and mountain sections. Young calves cannot be pastured successfully in the wet coastal areas because of the greater abundance of parasites. Older cattle may be pastured in these wet areas with considerable safety, if proper measures are used in controlling the liver fluke.

Overstocking of pasture, a common practice in Puerto Rico, favors the infection of animals by parasites. Heavy stocking means more manure and this in turn results in heavier concentration of parasite eggs and larvae. Animals grazing on such pastures have greater opportunity for picking up parasite eggs and larvae. However, overstocking is sometimes a relative term. During the dry season a pasture may be overstocked, but during the wet season with a much heavier growth of grass the same pasture may have a much higher carrying capacity. The overstocking in the dry season may not cause the same amount of infestation as a similar overstocking in the rainy season, owing to the presence of fewer parasites.

Pasture rotation is an excellent method of parasite control. To prevent setting up dangerous infestations, it is advisable that calves be moved every 2 weeks to clean pastures, during the wet season, and should not be returned to the same pasture for at least 8 months. Such a system of management requires considerable fencing and more land than is usually available. Consequently a modification of this program or other control measures are necessary. However, any rotation is valuable, especially with heavy stocking. The more often calves can be moved into clean pastures, the more effectively infestation will be kept down.

Stock rotation is another means of helping to control parasites. Horses and cattle are maintained in separate pastures and alternated twice a year. Theoretically the changes should be made about the middle of both the dry and wet seasons. The saying, "Permanent pastures perpetuate parasites", applies here as elsewhere, especially as pastures in this climate are used throughout the year, and there are no crops or land available for temporary pastures.

Location of the pasture is important in controlling parasites. Pastures, especially for calves, should be confined to the hillsides, because bottom lands, being less thoroughly drained and receiving the wash from the hillsides, are likely to be more highly infested with eggs and larvae of parasites than the hill lands. Calves should be kept away from low spots in the pasture by fencing and should be watered in troughs from which there is no overflow. A small bog surrounding a watering trough or spring may provide sufficient moisture for the propagation of parasites and thus serve as a constant source of infestation. The bottom lands may be used for field crops or if necessary for pasturing mature cattle.

CONSTRUCTION OF PENS FOR YOUNG STOCK

Dark, damp, and dirty pens or stables provide conditions favorable for the development of parasites. Therefore, the proper construction of pens for confined animals is an important factor in the control of parasites and disease. The open-shed type of building in common use is well adapted for local conditions. Advantage should be taken of the fact that the sun shines nearly every day throughout the year in Puerto Rico. The sun's rays provide an efficient and inexpensive drier and disinfectant and are very destructive to the eggs and larvae of parasites. The pen should face east and west and the sides and roof should be so constructed that the direct rays of the sun can reach the entire floor space. Tight floors, preferably of concrete with drainage facilities, are essential. The mangers

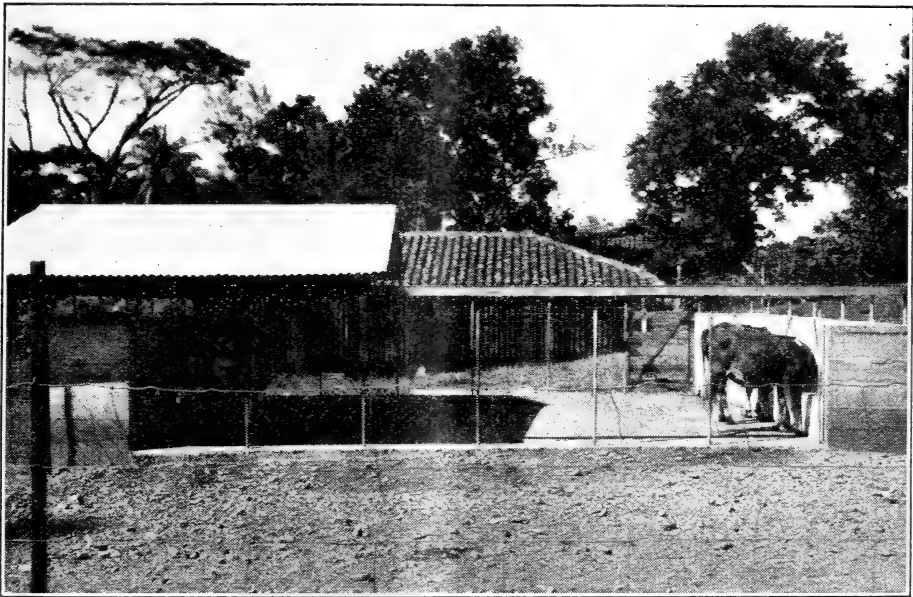


FIGURE 1.—A sanitary calf pen with movable roof. Exercising yard in foreground.

and troughs should be protected from fecal contamination. A yard or corral may be used in connection with the pens, provided it is a bare lot, unshaded, and with good drainage. Young animals should have plenty of exercise and direct sunlight.

A modified type of such a pen (fig. 1) has been constructed for trial at the station. The roof of this pen is built lower than an ordinary roof. It covers one-half the pen and it is set on rollers. Each day as the pen is cleaned the roof is moved over to cover the opposite half of the pen. Thus all parts of the pen are exposed to the sun on at least alternate days. Such a construction provides sufficient shelter for this climate and allows the sun to shine directly into the pen for a greater length of time than the ordinary type of roof.

MEDICINAL TREATMENT

The factors involved in the treatment of parasites, including the diagnosis, the specific drug to be used, the dose, and administration, usually require the knowledge, skill, and also the equipment of a

veterinarian. If a veterinarian is not available the owner must use his own judgment in determining whether he can recognize the trouble and administer the remedy.

The most common method of administering remedies used by stockmen is drenching or giving the medicine as a solution from a long-necked bottle, by way of the mouth. The animal should remain on all four legs with the head held horizontally and in line with the body. The practice of elevating the head as high as possible, twisting the neck, closing the nostrils, and then pouring the drench rapidly into the mouth may result in all or part of the solution going into the lungs and either drowning the animal or producing a fatal pneumonia.

Fasting or withholding food for a certain length of time (p. 13) before and after the administration of worm remedies is quite important and should not be neglected. The bulk of the contents of the digestive tract is thereby reduced, thus allowing the drug to reach the parasites more certainly and effectively. A program of regular treatments should be adopted. The usual procedure for the parasites of calves and goats is to dose once a month or more often if necessary. Judgment based on experience is more valuable than any general rule.

OTHER CONTROL MEASURES

From the standpoint of parasites and diseases, calves and all young animals should be separated from older animals when they are a few days old and should not come in contact with them. Older animals carry and spread parasites and diseases, and the areas occupied by them are infested. The local custom of allowing calves to start the milk flow and to strip the udder of their dams during the entire lactation period is a poor dairy practice and dangerous to the calf. Goats, both young and old, should not be brought into contact with calves, as goats are usually infested with stomach worms and other worms common to calves. Stray animals may be another source of infestation.

Calves up to 3 or 4 weeks of age should be kept in individual pens, and may then be placed in larger pens with other calves of the same age. Calves raised in the wet coastal area should not be placed on pasture until they are at least 1 year of age. At this age a healthy calf seems to have gained sufficient resistance to the roundworms so that very little injury is caused by them. However, if calves of this age or older are for any reason in poor physical condition, their resistance is reduced and they may suffer from intestinal parasites.

The practice of placing calves less than 1 year of age on pasture and treating them regularly with anthelmintics every few weeks has not been successful. The calves usually become heavily infested with injurious worms, such as lungworms and nodular worms, which are not readily destroyed by treatment. A few dairymen have avoided the difficulties of raising calves in the wet coastal areas by placing the animals on pastures in the dry areas or mountain sections.

The pens and exercising yards for calves should be cleaned every day in order to prevent the development of parasite eggs and larvae in them. A supply of fresh clean water should be available at all times. Salt and a mineral mixture should be provided. The latter

not only supplies minerals that are often lacking in local soils but also helps to prevent the calves from licking the walls and floors of the pen and picking up parasites and disease germs.

Improper feeding and management, as well as parasitic diseases, cause unthriftiness, emaciation, and stunting in calves. Among the causes of failure to raise normal, healthy calves is the common practice of feeding them largely or solely on fresh grass. The low-protein, bulky forage grasses in common use are unsuited to the limited capacity of the stomach of the young calf. These grasses should be supplemented with larger proportions of skim milk and grain. There are more difficulties to overcome in raising young stock in Puerto Rico than in many other localities and climates.

DISEASES OF CATTLE CAUSED BY PROTOZOA

PIROPLASMOSIS, TICK FEVER, OR "FIEBRE TEJANA"

Tick fever is caused by *Piroplasma bigeminum*, a microparasite located in the blood (fig. 2, *Aa*). These organisms enter the red blood corpuscles and cause them to disintegrate.

Life history.—The piroplasma are transmitted by the common cattle tick. The tick becomes infected from the blood of an animal that harbors the organism, and the infection is carried through the egg to the young ticks of the next generation. These young ticks may infect any susceptible animal (bovine) to which they become attached.

Importance.—About one-third of the imported cattle from tick-free localities are said to die from this disease. Native cattle, especially the higher-bred dairy cattle, suffer from the disease, although the attacks are usually of short duration and death does not occur as a rule.

Symptoms.—The first symptom usually noticed is extreme dullness, loss of appetite, and, in milking cows, a decided drop in production. Other symptoms are a fever temperature which may be as high as 41.5° to 42.2° C. (107° to 108° F.), constipation, and loss of flesh. The feces are usually heavily stained with bile and sometimes with blood. The blood itself is pale and watery. A coffee-colored or blood-colored urine is characteristic of the disease.

Treatment.—The sick animal should be placed immediately in a cool, shady pen and the ticks removed from the skin. The back and sides of the animal may be covered with a thickness of burlap and sprinkled frequently with water. Unnecessary driving or rough handling should be avoided. A small dose of a saline purge may be given if there is constipation. Stimulants to support the heart action are indicated.

Intravenous injections of trypan-blue have been used with good results in Africa and South America. The usual dose is 1 gram dissolved in 100 cubic centimeters of a sterile physiologic salt solution. It should be administered as soon as possible after the symptoms appear.

Prevention.—This disease can be eliminated by eradicating the cattle ticks from the island (p. 22). Cattle become immune to tick fever after recovery from an acute attack. This fact has led to the development of several methods of immunizing cattle to the

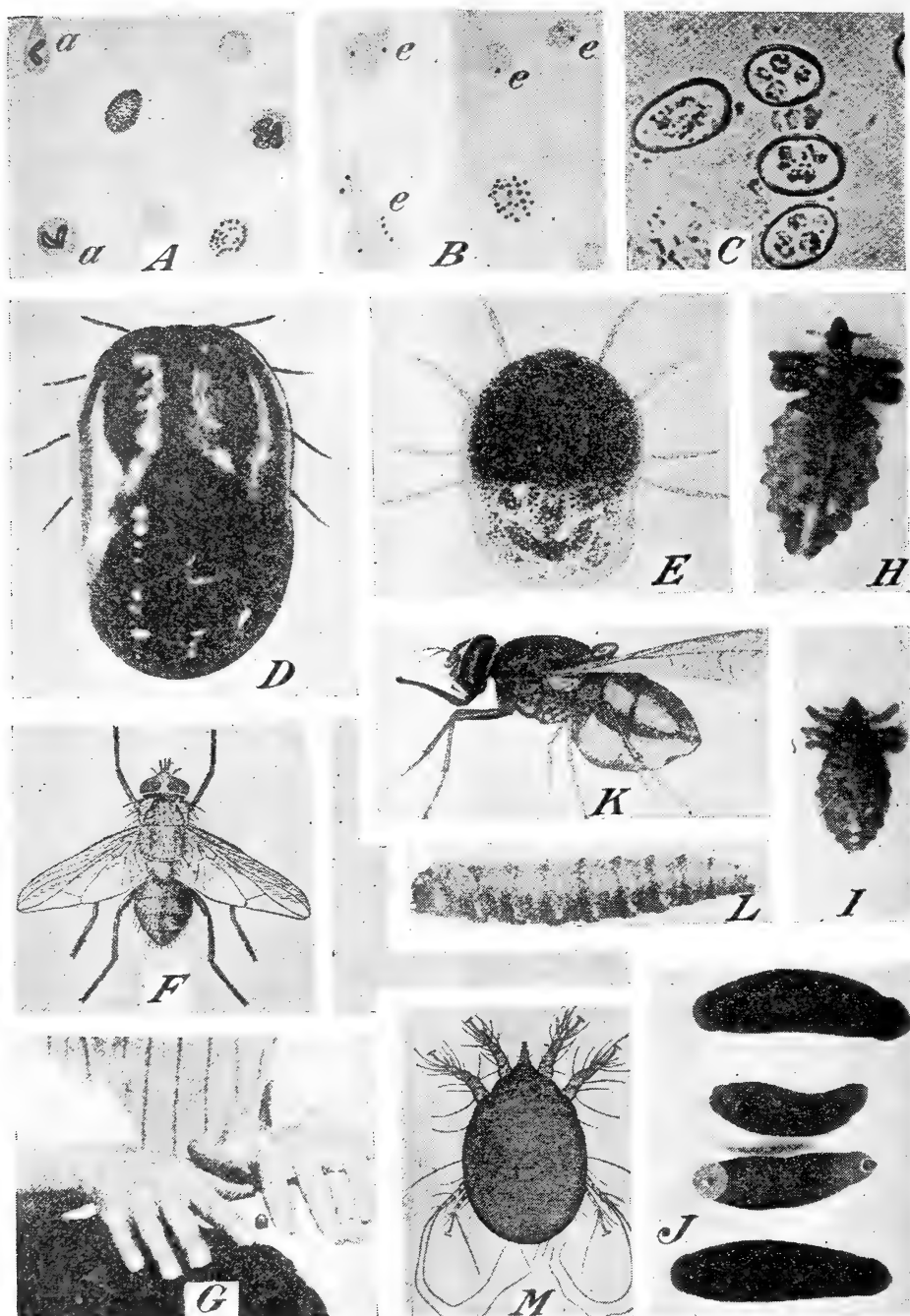


FIGURE 2.—Protozoan and external parasites of Puerto Rican cattle: *Aa*, Red blood cells showing tick-fever parasites (from Stiles, 1931). *Be*, Red blood cells showing anaplasma (from Stiles, 1931). *C*, Coccidia from cattle, $\times 650$ (from Wilson, 1931). *D*, Cattle tick, engorged female, $\times 4$ (from Graybill). *F*, Hornfly, $\times 5$ (from Riley and Howard). *G*, Extracting a grub or warble from a cow's back (from Bishopp, Laake, and Wells). *H*, Tail louse, $\times 8$. *I*, Short-nosed ox louse, $\times 8$. *J*, Leeches unengorged with blood. *K*, Stable fly, adult female, side view; engorged with blood, $\times 5$ (from Bishopp). *L*, Screw-worm maggot, side view, $\times 5$ (from Bishopp, Mitchell, and Parman). *M*, Psoroptic mange mite, female; dorsal view, $\times 40$ (after Salmon and Stiles).

disease. Probably the safest method for pure-bred cattle is by injecting blood from immune animals into those that are susceptible. To insure the success of this method, natural infestations with the tick must be avoided. It is recommended that animals from 6 to 15 months of age be selected for inoculation, as they are more readily immunized than adults. The treatment with trypan-blue should be used to ease the severe reactions and to reduce the losses resulting from the immunization.

A control measure that has been tried in Puerto Rico, with varying results, is to allow only a limited number of ticks to infest the susceptible imported animals. These animals are isolated, at the time of arrival, in a stable or bare corral, and sprayed every week or two with an arsenical solution. They become infested with a few or several ticks for a short interval, and the disease is produced, but the proportion of deaths is usually small when compared with the fatalities among uncontrolled animals. The ticks infesting these animals are picked up from the forage grasses. The animals should receive medicinal treatment as soon as they show signs of the disease.

Calves of 1 year of age or less can be introduced with considerable safety, as the disease is usually mild and less fatal in young animals. The importation of mature cows in an advanced stage of pregnancy should be avoided, as they are likely to succumb to the disease.

ANAPLASMOSIS

The organism *Anaplasma marginale* associated with anaplasmosis (fig. 2, *Be*) appears in stained blood smears, as a small, dark, dotlike object, usually on the margin of the red blood cells. The disease itself resembles piroplasmosis in many respects, and the two diseases are being confused.

Life history.—The disease is spread by cattle ticks and other ticks. As in the case of piroplasmosis, the cattle tick (*Boophilus annulatus*) engorged on anaplasmosis carriers can transmit the disease to susceptible animals in the next generation. Various biting flies have also been reported as carriers of the disease. In connection with the transmission of this disease it should be mentioned that anaplasmosis can be carried from one animal to another by instruments such as hypodermic needles, lancets, and dehorning shears.

Importance.—Apparently this disease occurs much more frequently among native and acclimated cattle than does piroplasmosis. Among these animals the percentage of fatalities is low. The higher producing milk cows seem to be more predisposed to the disease and are often attacked at the time of parturition. Animals may recover from the disease, but the milk production is lowered or may cease, and is not resumed until the next parturition. As with piroplasmosis, the disease may spread rapidly among susceptible imported cattle and may result in a high mortality. As the period of incubation of anaplasmosis is longer than that of tick fever, an imported animal may recover from the latter and then in a few days or a few weeks suffer from an attack of anaplasmosis.

Symptoms.—The symptoms are similar to those of tick fever except that the urine is rarely, if ever, blood-colored, although it may

be darker than normal due to the presence of bile pigment. An accurate diagnosis of the disease can be made by microscopic examination of the blood.

Treatment.—The management and treatment of sick animals is the same as that recommended for piroplasmosis except that trypan-blue is of no value. There is no known specific for treating this disease. A veterinarian should be called at once as delay may result in the death of sick animals.

Prevention.—Susceptible imported cattle should be managed as described under piroplasmosis. Any instrument which may carry or inoculate the fresh blood of one animal into that of another, such as dehorning instruments, syringe needles, etc., should be cleaned and disinfected after each operation. As the carriers of this disease are imperfectly known, the control measures recommended at this time are incomplete.

The prevention of both anaplasmosis and piroplasmosis in native cattle is practically impossible under existing conditions. As a result of lowered vitality caused by some other disease, by parturition, or by exposure, privation, injury, and rough handling, the immunity of the animal becomes reduced and finally overcome and one or the other of these diseases may occur. Often there is no indication of an impoverished condition. The most that can be done is to avoid anything that may tend to lower the resistance of the animal. The high-producing milk cow should have a long rest period and should be fed well and carefully handled previous to parturition. The cattle tick should be controlled by frequent dipping or spraying.

COCCIDIOSIS

The coccidia *Eimeris* spp. (fig. 2, *C*), are microscopic round or oval organisms which attack the mucosa or lining of the intestine.

Life history.—Infection is conveyed by contaminated food and water. The coccidia in the body multiply in large numbers, but after several generations an encysted stage is produced which passes out in the feces. The disease is self-limited and ultimately dies out in the absence of reinfection.

Importance.—Coccidia are often found in feces of cattle, especially during and following the wet season. The finding of these organisms indicates that the animal has zoological coccidiosis, but not necessarily clinical coccidiosis as coccidia may occur in apparently normal animals. This is usually a disease of young stock but also occurs in older animals. This disease seems to be uncommon although it is possible that it is not always recognized.

Symptoms.—Coccidiosis is an acute disease and often terminates fatally. The first noticeable symptom is a diarrhea in which the feces contain mucus and blood. Later there is a loss of appetite, loss of flesh, and a slight fever. A fetid, bloody diarrhea may develop.

Treatment.—Preventive treatment seems to be the only feasible program known at present. Medicinal treatment should be given by a veterinarian. As the seriousness of the disease depends considerably on the number of organisms taken into the body, measures should be taken to keep the numbers ingested at a minimum. The

sick animal should be placed in a clean dry pen. Either dry hay or clean fresh grass obtained from a hillside or dry field should be fed. The animal may be muzzled after eating and drinking. The pens should be scrubbed, sprayed with a hot disinfectant, and dried. The organism is very resistant to ordinary disinfectants, but it can be destroyed by heat and drying.

Prevention.—Cattle should be kept away from low, wet pastures. An open manure pile draining into a pasture or grass field is dangerous. The ingestion of dirty water from pools and marshes must be avoided. For confined calves, clean fresh grass, clean water, and clean dry pens should be provided.

WORM PARASITES

THE STOMACH WORM

The stomach worm (*Haemonchus contortus*) (fig. 3, A) is a round-worm found in the fourth stomach (abomasum) of cattle. The worms are 12 to 30 millimeters ($\frac{1}{2}$ to $1\frac{1}{4}$ inches) long and about as thick as an ordinary pin. The female worms are larger than the males and have a spiral striping. The smaller male may be distinguished by the fact that the posterior or tail end of the body is flattened and expanded.

Life history.—The eggs are passed in the feces and develop on the ground. In 10 days or sooner the infective larvae crawl up on the blades of grass when there is a rain or dew. Animals become infested by grazing, by eating contaminated forage grasses, or by picking up the larvae which have developed in damp and dirty pens.

Importance.—The stomach worm is one of the most common and most serious parasites of cattle in Puerto Rico. Calves of less than 6 months of age are more susceptible to and more seriously injured by infestation than older animals. Healthy calves of 1 year of age, or older, which are fed properly, become quite resistant to infestation. Mature cattle often harbor a few stomach worms but are rarely injured by them.

Symptoms and lesions.—The worm attaches itself to the lining of the stomach and sucks blood, producing pin-point punctures with hemorrhages. The first symptoms are dullness and unthriftiness, and, later, anemia and edema. The condition known as "papera" in which there is a swelling underneath the jaw (fig. 4) is a sign of infestation by this parasite. This swelling is also found in infestations with the hookworm and liver fluke.

Treatment.—A satisfactory treatment is by drenching with a 1-percent solution of copper sulphate. The dose for a calf 3 months of age is 60 cubic centimeters (2 ounces), and for each additional month of age add 15 cubic centimeters, or at the rate of approximately $1\frac{1}{2}$ ounces per 100 pounds (1 cubic centimeter per kilogram) of live weight. All food should be withheld 18 hours before, and both food and water 4 to 6 hours after, treatment.

To make a 1-percent solution of copper sulphate dissolve 100 grams of copper sulphate in 1 liter of boiling water and add 9 liters of cold water, or at the rate of one-fourth pound of copper sulphate to 3 gallons of water. Select only the clear blue crystals of copper

sulphate, discarding those that have turned white. Porcelain or enamel-ware receptacles should be used in preparing and handling the solution, as it will corrode metals. If a large number of animals

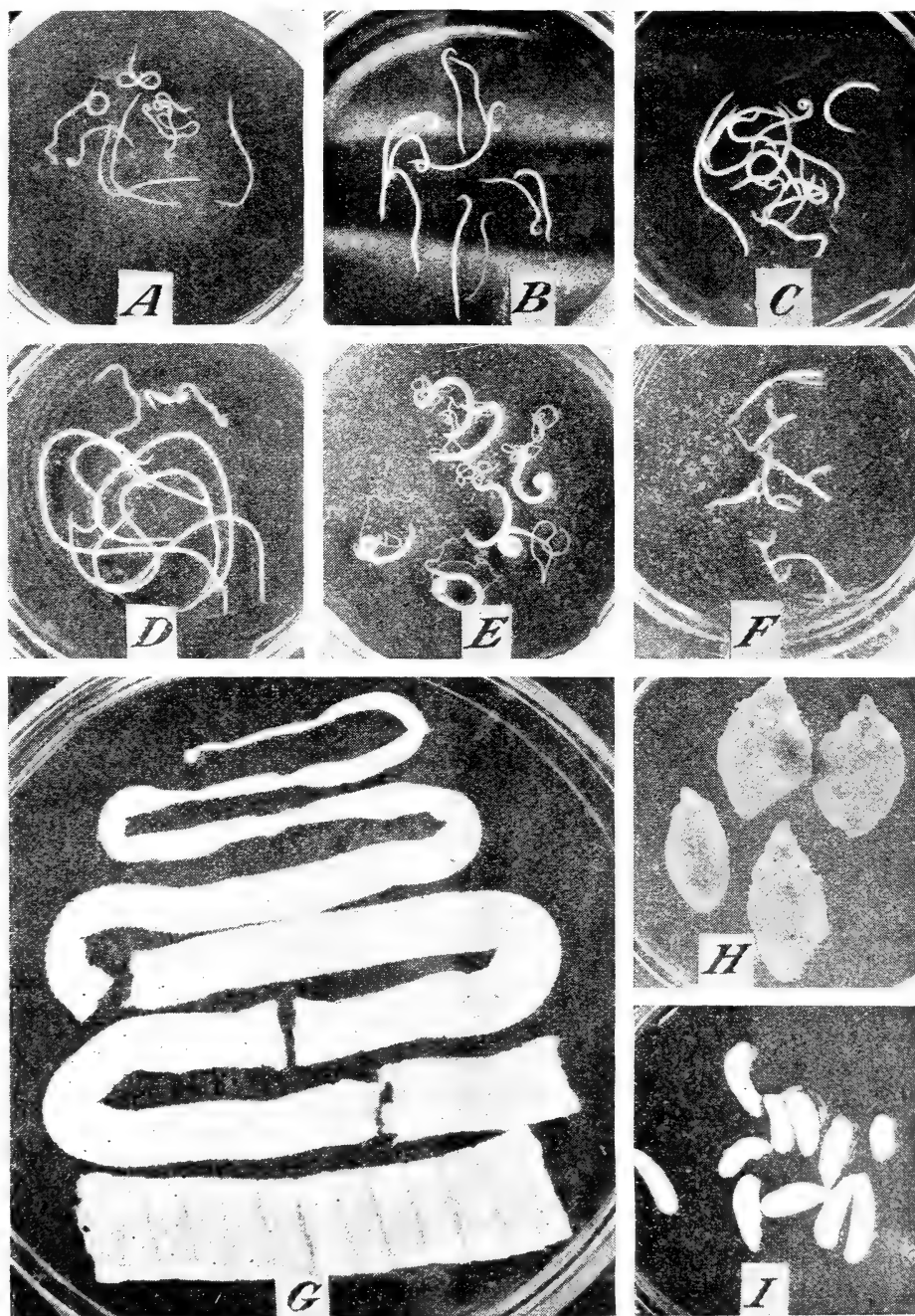


FIGURE 3.—Worm parasites of Puerto Rican cattle: *A*, Stomach worms; *B*, nodular worms; *C*, hookworms; *D*, lungworms; *E*, whipworms; *F*, laryngeal worms; *G*, tapeworm; *H*, liver flukes; *I*, stomach flukes. All natural size.

are to be treated the device described by Hall² may be used. For stockmen that have a comparatively small number of animals, but

² HALL, M. C. PARASITES AND PARASITIC DISEASES OF SHEEP. U.S. Dept. Agr. Farmers' Bul. 1330, 54 pp., illus. 1923.

who wish to dose regularly, a concentrated stock solution may be made by dissolving 200 grams of copper sulphate in 1 liter of distilled water or rain water. Such a solution will retain its strength indefinitely. In making the dilution for administration, add 50 cubic centimeters of the stock solution to 950 cubic centimeters of water, or in this proportion.

Prevention.—Confined calves should be provided with dry sanitary pens and should be fed on uncontaminated grass. Pastured animals should be given a wide range on dry hillside pastures. If necessary, both the confined and pastured animals should be treated. Periodic treatments, every 2 or 3 weeks, should be given instead of waiting until the animals show symptoms of the disease. On some pastures where heavy stocking is practiced, it is necessary to dose every 2 weeks during the wet season.

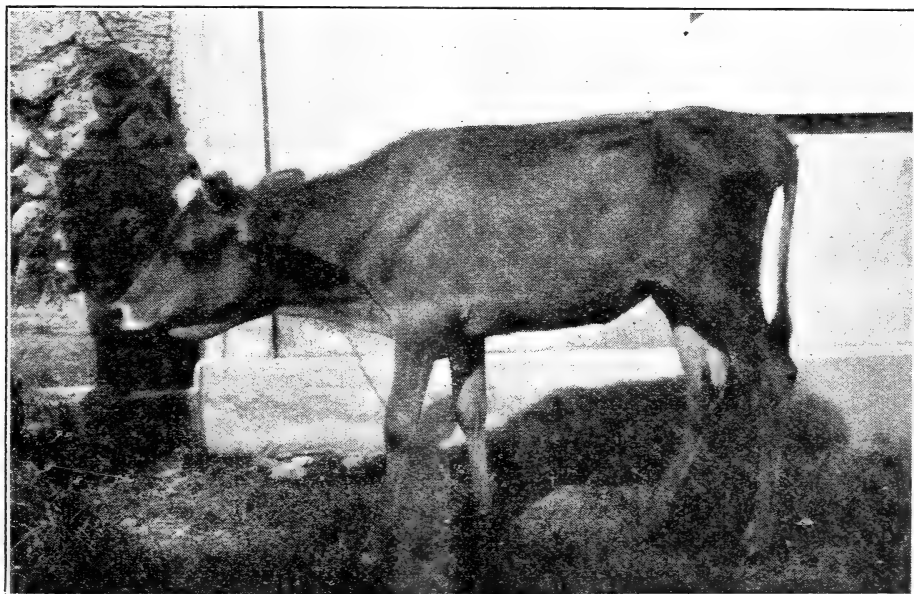


FIGURE 4.—Calf with "papera" or edematous swelling underneath the jaw. This calf was infested with stomach worms.

THE NODULAR WORM

The nodular worm (*Oesophagostomum radiatum*) is about 15 millimeters (five-eighths of an inch) long. It has a characteristic solid white body. The adult worms live in the large intestine. The larval worms live in nodules in the wall of the intestines and occasionally make their way to the mesenteric lymph glands, the omentum, or the liver. The nodules are usually found in the terminal portions of the small intestine.

Life history.—The eggs are passed with the manure and the young worms are hatched and undergo some development on the ground. When swallowed by cattle, the young worms enter the walls of the intestine and remain for a few days and then return to the lumen of the large intestine, where they reach maturity. Following this encysted stage in the walls of the intestine, the nodules formed often increase in size and contain a yellowish or greenish, cheesy or calcareous material.

Importance.—The nodular worm is common and serious especially in the wet coastal areas and lower mountain regions. It occurs in cattle of the southern coastal plain, but it is considerably less important in this area. Similar to other roundworms, young calves are more susceptible to and more seriously injured by infestation with nodular worms than older cattle.

Symptoms and lesions.—The injury by this parasite seems to occur largely from the nodules. The large number of nodules resulting from a heavy infestation prevents the intestine from functioning properly, and they are a constant source of irritation to the sensitive tissue of the intestinal tract. Because of the permanent nature of the nodules, calves may recover slowly from a heavy infestation. The symptoms are dullness, lack of thrift, and diarrhea.

Treatment.—Preventive measures must be relied on for controlling this parasite. There is no known remedy that will reach the young worms in the nodules. As the injury by the parasite is largely from the nodules, medicinal treatment cannot relieve or improve this condition. A drug to destroy the mature worms in the large intestine, which is both efficient and safe for cattle, has not been found. Such a drug would be valuable in eliminating the ova-producing worms and thus assisting in the control of pasture, field, and stable infestations.

Prevention.—Pasturing young calves in the areas most favorable for this parasite should not be attempted. In the other areas calves should be maintained on dry hillsides. If dry pastures are not available, calves should be confined during the wet season. Confined calves can be protected from infestation by feeding the giant grasses or other clean grasses and by providing clean, dry pens and corrals. Because this worm is very common and serious, and medicinal treatment is unsatisfactory, careful preventive measures are essential.

HOOKWORM

The hookworm (*Bunostomum phlebotomum*) is located in the small intestine. The female hookworm is about 2 centimeters (three-fourths of an inch) long, and the male is shorter and more slender.

Life history.—The life history is similar to that of the stomach worm. Infestation is by way of the mouth and possibly the larvae are capable of penetrating the skin.

Importance.—The hookworm is not as widely distributed as either the stomach or nodular worms. Considering the island as a whole, it is more common and serious among calves of the southern coastal area. This parasite shows a preference for porous soils. At Mayaguez, where the soils are mostly a heavy clay, the worm is more common among the calves raised on the sandy soils near the seashore.

Symptoms and lesions.—The worm is a bloodsucker, and the symptoms and lesions are similar to those of the stomach worm.

Treatment.—A solution containing the copper sulphate solution, as described for the stomach worm (p. 13), combined with nicotine, is effective for hookworms. To make this solution, add 1 ounce of 40-percent nicotine sulphate to 1 gallon of 1-percent copper sulphate (10 cubic centimeters to 1 liter). The dose for this combination is

the same as for the copper sulphate alone. However, this combination is more toxic and the amount given should be diminished if the full dose produces unpleasant symptoms. It should not be given to very young animals nor to animals suffering from disease conditions other than those of parasitic origin. Calves which are in poor condition because of improper feeding and infestations with parasites should be given small doses of this combination. The strength of these animals should be built up by supplying sufficient amounts of suitable concentrates. Animals frequently show symptoms of distress after the first few dosings with this combination, but tolerate it better later. Alternating the use of this solution with the straight copper sulphate solution is a good practice.

Prevention.—Same as for the stomach worms and nodular worms.

THREAD LUNGWORM

The lungworm (*Dictyocaulus viviparus*) (fig. 3, *D*) is found in the air passages, bronchi, and bronchioles of the lungs. They are rather large worms, ranging from 4 to 8 centimeters in length.

Life history.—The eggs hatch in the lung and the larvae ascend the trachea and are expelled in coughing or swallowed and passed in the feces. The infective stage may be reached in 10 days or less. The infective larvae climb up the blades of grass when they are wet, as do the larvae of stomach worms and here they are taken in by grazing calves and make their way to the lungs. Infection may also be obtained from contaminated grass and from the larvae that have developed in damp and dirty pens. However, this is usually a pasture disease, and confined calves, regardless of the system of management, seem to be less subject to infestation with lungworms than with some of the other roundworms.

Importance.—Heavy infestations with this lungworm are not so common as with some of the intestinal worms. However, on many farms it is one of the most serious parasites of calves. Attempting to pasture young calves in the wet coastal areas usually results in massive infestations. In the dry areas and mountain sections, calves having access to low, wet pastures may also become heavily infested.

Symptoms and lesions.—The first symptom is a husky cough which may be followed by difficulty in breathing. The animal may die from suffocation, or a fatal pneumonia may develop. In the more common prolonged cases, the animal becomes emaciated, anemic, the eye sunken, and there is loss of appetite. Diarrhea is a common symptom.

Treatment.—Nursing treatment appears to be the safest and most satisfactory in most cases. Infested calves should be confined and provided with a safe drinking water and a plentiful supply of dry hay or clean grass and concentrates. Sanitary measures should be taken to prevent fresh infestations in the pen. The animals should be treated with the copper sulphate-nicotine sulphate solution to remove the gastro-intestinal worms that are usually present with this worm.

Prevention.—Medicinal treatment, if attempted, should be given by a veterinarian. In the wet coastal areas, calves up to 1 year of age should be confined. The confined calves should be fed on the

giant grasses and provided with clean, dry pens. In the dry areas and mountain regions, calves should be pastured on the hillsides and should not have access to wet or marshy land.

LIVER FLUKE, "LINGUA" OR "CUCARACHA"

The liver fluke (*Fasciola hepatica*) (fig. 3, *H*) is found usually in the canals and ducts of the liver, although the flukes may occur as wandering parasites in the lungs and elsewhere. This fluke is a flattened, leaflike, brown animal about 1 inch long.

Life history.—The eggs pass out in the feces and, if they get to water, they develop in about 3 weeks and release a motile embryo. This embryo swims about and enters a snail (*Lymnaea cubensis*), in which another stage of development takes place. A small fluke-like cercaria with a tail is produced in the snail, and this cercaria emerges and swims about and in a short time encysts. This encysted form may float on water or it may become attached to grass. When these are swallowed by cattle or other suitable host animals, the larval flukes escape into the digestive tract and bore their way through the intestinal walls to the body cavity. As a rule, they perforate the capsule of the liver and enter the bile ducts, while a few may perforate the diaphragm, getting into the lungs.

Importance.—The liver fluke is a common and serious pest of cattle in the wet coastal and lower mountain areas. This parasite also infests the goat, pig, horse, and man. Mature animals as well as the young may suffer serious injury or die from infestation. In dairy cows there is a loss in milk production and breeding efficiency. Work bulls are weakened and made unfit for service. There is another loss in that all infested livers are condemned at the abattoirs.

Symptoms and lesions.—Loss of condition, anemia, and edema are associated with this parasite. The fluke causes considerable damage to the liver, which in cattle especially is of a permanent nature, since heavy infestation in cattle is followed by a calcification of the bile ducts. Complete recovery is hardly possible because of the permanent injury to the liver tissue.

Treatment.—No treatment is recommended for flukes in cattle. The permanent injury to the liver cannot be relieved or improved by treatment. Infections in cattle may be controlled by destruction of the snails responsible for carrying the young flukes.

Prevention.—The snail which is essential to complete the life cycle of this fluke can be destroyed by proper drainage or by treating the water and mud with copper sulphate. This snail lives in the mud, in stagnant fresh water, and in sluggish streams and drainage ditches but not in swift-running water or in gravelly stream beds. A mixture of 1 part powdered copper sulphate to 4 or 8 parts of dry sand may be broadcast by hand over the snail-infested areas at the rate of 5 to 6 pounds of copper sulphate to the acre.

The snails in streams and ditches may be destroyed by putting a gunny sack containing crystals of copper sulphate in the head waters. Damming the streams at intervals aids in destroying snails along the banks. The copper sulphate is capable of destroying the snails in a stream as far down as the water retains a bluish color.

Technically, the amount to use is 12 pounds of copper sulphate per second-foot of flow for running water and about 6 pounds per acre-foot of water for marshy land. As this amount of copper sulphate is too small to distribute evenly, it should be mixed with a carrier. If the copper sulphate is distributed uniformly, there is little danger of animals being poisoned by it.

The best season of the year for the treatment is a short time after the heavy rains of the rainy season. As the land gradually dries off, the remaining water tends to collect in depressions or pools and the snails follow the water line and become concentrated in these centers. Later, if treatment is not undertaken, the snails disappear in cracks and holes in the soil and cannot be reached by ordinary methods. Until island-wide eradication measures are undertaken, it will be necessary to repeat the operation every year or as often as the snails reappear. If live snails are found after an application, the treatment should be repeated. Usually one treatment at the right time of the year is sufficient for that year. At the experiment station at Mayaguez the pastures and malojillo vegas are treated some time during November or December.

TAPEWORM

The tapeworm (*Moniezia expansa*) (fig. 3, *G*) is a whitish, segmented worm which may attain a length of several feet. It is found in the small intestine.

Life history.—Unknown.

Importance.—This worm is very common in some districts. Of the cattle slaughtered at Mayaguez, this tapeworm seems to be more common in those obtained from the district of San Sebastian. The heaviest infestations occur more frequently among pastured animals. Confined calves that are kept in sanitary pens and fed on the clean grasses occasionally become infested.

Symptoms and lesions.—The worm causes obstruction of the intestine and irritation, and infested animals become unthrifty, weak, and emaciated. Diarrhea is a common symptom. Occasionally the presence of the worm is detected by the passage of several or many of the end segments in the feces.

Treatment.—Various treatments have been recommended. However, most of the recommended drugs are unsafe for the young stock which harbor the heaviest infestations and are in greatest need of treatment. Care must be used also in giving any anthelmintic, as many of the young animals besides harboring various kinds of parasites are improperly nourished and thus are poor subjects for treatment with any potent drug.

Kamala administered in capsules in doses of 1 to 2 drams (4 to 8 grams) for calves up to 1 year of age may be used. It should not be given to very young animals or to those in a weakened condition. Periodic treatment with the copper sulphate-nicotine sulphate combination as recommended for the hookworm seems to reduce infestations with this tapeworm.

Prevention.—No dependable preventive measures against these tapeworms can be recommended, owing to the fact that the life history is unknown. However, as the ova are the starting point of

new infestations and these are eliminated with the manure, any measures which are taken in regard to the proper disposal of manure will aid in preventing infestations with this tapeworm.

OTHER WORM PARASITES

The whipworm (*Trichuris ovis*) (fig. 3, *E*) is found in the large intestine of cattle and goats. This worm is common in calves. The body of the worm is thick posteriorly and very slender anteriorly, the anterior portion of the body being 2 or 3 times as long as the posterior portion. Whipworms set up an inflammation, with the likelihood of the lining of the intestine being infected by bacteria. Because of their location, treatment with anthelmintics is not very effective. The preventive measures as given for stomach worms (p. 15) and other worms should be followed.

Syngamiasis caused by the worm *Syngamus laryngeus* (fig. 3, *F*) in the larynx, occurs in cattle and goats. The worm appears to be double-headed and Y-shaped because the shorter male is attached to the larger female worm. It appears to give rise only to a local lesion at the point of attachment. Infestations by 1 or 2 worms, in man, have caused considerable irritation. The worm is common and rather conspicuous and, because of its location, stockmen are likely to ascribe to it the symptoms of lungworm infestation.

The stomach fluke (*Cotylophoron cotylophorum*) (fig. 3, *I*) is found attached among the papillae of the rumen or paunch of cattle. It is about 12 millimeters (one-half inch) in length and conical in shape. This conical fluke is found in the same districts as the liver fluke. Similar to the liver fluke it is common in both young and mature animals. It is usually considered as not impairing the health of the host but massive infestations, which sometimes occur, apparently cause emaciation. Infestations can be prevented by destroying the snails as described for the liver fluke.

Several other kinds of roundworms have been found in the stomach (abomasum) and small intestine of cattle. The species have been identified as *Haemonchus similis*, *Ostertagia ostertagi*, *Trichostrongylus axei*, *Cooperia punctata*, *Capillaria brevipes*, and *Strongyloides papillosus*. These worms may be overlooked if they occur in small numbers together with infestations of the more conspicuous stomach worms or hookworms. Most of these worms, and probably all of them, are injurious, but at present they are, so far as known, of relatively less importance in comparison with stomach worms, hookworms, and nodular worms. The method of prevention as recommended for stomach worms, and other worms, will help to protect cattle from infestations with these worms.

The bladderworm (*Cysticercus bovis*) is about the size of a pea and is grayish white in color. It may be found in any organ but usually in the muscles of the jaw, tongue, heart, and diaphragm. It is apparently uncommon locally in cattle and is rarely detected in the slaughtered animal. The prevention of infestation in cattle is dependent upon the proper disposal of the excrement of man. The bladderworm is the intermediate stage of the beef tapeworm (*Taenia saginata*) in man. In Puerto Rico the beef tapeworm is said to be more common than the pork tapeworm. Eating raw or partially

cooked beef containing the bladderworms may result in infestation with the tapeworm. A man infested with a tapeworm expels several hundred proglottids a month, each containing many thousands of eggs. Cattle are infested by eating human excrement or by swallowing the eggs in contaminated feed and water. All beef should be thoroughly cooked before it is eaten in order to destroy this intermediate stage or else subjected to adequate meat inspection by competent veterinarians.

The threadworm (*Setaria labiato-papillosa*) is a slender, whitish worm from 2 to 5 inches in length. It usually occurs in the peritoneal cavity. A few of these worms are often found in cattle. These worms do not appear to do much damage and are not known to cause any definite symptoms.

The neck threadworm (*Onchocerca gutturosa*) is found in the large ligament of the neck. This is a slender, whitish worm from 1 to 2 inches or more in length. Most of the cattle that are slaughtered for meat purposes are infested with this worm. As far as can be determined, this worm is not harmful to the animal aside from causing a slight local irritation.

EXTERNAL PARASITES

CATTLE TICK OR GARRAPATA

The North American cattle tick (*Boophilus annulatus*) (fig. 2, *D*) and the Australian cattle tick (*B. annulatus australis*) are found attached to the skin of cattle and occasionally goats and horses. These are the common ticks found on cattle. At Mayaguez, the Australian variety is more common than the other.

Life history.—Both ticks mature on cattle and horses and the Australian tick matures on goats as well. The engorged female drops from the animal to the ground where it may deposit from a few hundred to more than 3,000 eggs. The eggs hatch in 2 weeks or longer, depending on external conditions. The young seed ticks are capable of living 3 or 4 months on the ground, if they do not become attached to a suitable host. After attachment the tick may become mature within 1 month. The entire life cycle may be completed within 6 weeks.

Importance.—These ticks are very abundant and are one of the most serious parasites of cattle. In addition to causing direct injuries, they transmit the diseases piroplasmosis and anaplasmosis.

Symptoms and lesions.—The direct injury by the cattle ticks is chiefly the drawing of blood from the host. As a result, growth is retarded, work animals are weakened, and milk production is reduced.

Treatment.—The ticks are controlled by "tickicides" used as sprays or dips. At present concentrated proprietary arsenical solutions are used almost exclusively. As these preparations and information concerning their use are readily available to stockmen, details in regard to treatment are not given.

Precautions should be used in the handling and dilution with water of the dips. Often animals are poisoned from too high a concentration of the arsenic in the solution. An animal may ab-

sorb sufficient arsenic through the skin to cause death. This usually occurs when the preparation is applied as a spray and the dilutions are made by persons unfamiliar with the danger involved. The dilutions stipulated by the manufacturer must be closely followed. A recommended dilution of 1 part of the stock solution to 155 parts of water is much less concentrated than the 1- to 3-percent solution of a disinfectant ordinarily used in the stable.

Prevention.—The most feasible method of control usually is to reduce the infestations to a minimum by routine dipping of cattle as often as necessary. Individual premises can be freed of ticks and maintained tick-free by proper dipping and quarantine measures, but cattle raised on these premises would be nonimmune to tick fever and thus the owner would be handicapped in selling animals other than for meat purposes.

The complete eradication of the cattle tick from the island would enable dairymen to bring in pure-bred animals for replacements and to improve the native stock without danger of death from tick fever.

Further information concerning treatment, eradication, and the diseases transmitted by this tick is available in various bulletins published by the United States Department of Agriculture.³

HORNFLY

The hornfly (*Haematobia serrata*) (fig. 2, *F*) is a bloodsucking fly that attacks cattle and also horses. This fly is about one-half the size of the common house fly. It is easily determined by its size and by the fact that it always bites or sucks blood with its wings spread and with the head toward the ground and in the same direction as the hair of the animal.

Life history.—The fly deposits its eggs in fresh cow manure. The larvae remain in the manure for 3 to 5 days before they burrow into the drier soil underneath to pupate. The adult fly emerges in 10 to 14 days after the eggs are deposited.

Importance.—In the southern coastal area of Puerto Rico this fly is very common and a very serious pest of cattle. Attacks by myriads of these flies are common. In the wet coastal areas it is considerably less important, but it is common at times, and control measures are necessary.

Symptoms and lesions.—The fly punctures the skin and sucks blood. The loss of blood is considerable where it attacks in large numbers. Animals sometimes lacerate the skin of the flanks with their horns while fighting the fly.

Treatment.—A spray consisting of a kerosene extract of pyrethrum is very effective in destroying these flies. Spraying morning and evening protects the animal from infestation and greatly reduces the number of flies.

Prevention.—The manure collected from stables should be stored in fly-tight pits or bins or spread immediately on fields. In dairy

³ ELLENBERGER, W. P., and CHAPIN, R. M. CATTLE-FEVER TICKS AND METHODS OF ERADICATION. U.S. Dept. Agr. Farmers' Bul. 1057, 32 pp., illus. 1919.

MOHLER, J. R. TICK FEVER. U.S. Dept. Agr. Farmers' Bul. 1625, 30 pp., illus. 1930.

STILES, G. W., JR. ANAPLASMOSIS IN CATTLE. U.S. Dept. Agr. Circ. 154, 10 pp., illus. 1931.

herds, the fly can be controlled by scattering all of the fresh droppings in the yards and pastures with a rake or other implement. The scattered manure dries out rapidly and the larvae die for lack of the moisture required for their development. Hogs and poultry assist in control by scattering the droppings and by eating the maggots.

OTHER EXTERNAL PARASITES

Common scab or "sarna" of cattle.—The mange mite (*Psoroptes communis*) (fig. 2, *M*) is found on the surface of the skin. It is a very small animal, which may be seen with the naked eye if placed on a dark background. Psoroptic mange is comparatively common, but in the climate of Puerto Rico it rarely becomes a serious disease. However, heavy infestations have been found among animals which were crowded together in small enclosures. The mite pricks the skin and sucks the blood serum. The first symptom noticed is itching, and later there is formation of scales and scabs and thickening of the skin.

Dipping or spraying with the lime-sulphur dip and the nicotine sulphur dip are effective remedies for this mange. Proprietary brands of these preparations, ready for use, are available. Cattle which are dipped regularly for ticks do not become infested with this kind of mange mite. For eradication of the mange the treatments must be repeated at intervals of 10 days. Two dippings may usually be depended on to cure ordinary cases. Four or more dippings may be necessary in chronic cases. After treatment the pens or stables housing the infested animals should be left vacant for a time or should be cleaned and disinfected with a strong solution of cresol to destroy the stray mites. Experiments carried out by the Bureau of Entomology, United States Department of Agriculture, in cooperation with the Texas Agricultural Experiment Station have shown that the longest period during which a pen remained infective was 10 days.

Sarcoptic mange caused by another variety of mite also occurs in cattle. This mite burrows into the skin, usually in locations where the skin is tender and the hair is thin. This disease is more serious than common scab because it is more severe in its effects and more difficult to eradicate. Sarcoptic mange of cattle is a rare disease, but local veterinarians report that infestations have occurred. The treatment is the same as given for psoroptic mange but it requires persistent, thorough, and frequent application of these preparations. A veterinarian should be consulted if the presence of this mange is suspected.

The screw worm.—The screw worm (*Cochliomyia americana*) (fig. 2, *L*) is the maggot of a blowfly which may attack any open wound of animals. The fly itself is not often noticed, but the maggots of this species are distinguished from the larvae of other common blowflies by their habit of penetrating practically sound tissue. The fly deposits its eggs in wounds, in masses of from 40 to 250 eggs. These eggs hatch in 3 hours or less and the maggots burrow into the wound and grow rapidly and become completely developed in 4 or 5 days. The injury is due to the eating away of the tissues and also to toxic secretions produced by the maggot. There is also serious danger

from hemorrhage and infection. Attacks from screw-worm flies may occur at any time of the year but are more frequent after the end of the rainy season.

The best treatment for an infested wound is to pour in benzol or chloroform, later remove the maggots, and apply pine-tar oil to prevent fresh attacks. The Bureau of Entomology, United States Department of Agriculture, recommends the use of commercial pine-tar oil with a specific gravity of 1.065 to 1.085. Probing and opening the burrows are regarded as inadvisable. All fresh wounds should be coated with pine-tar oil to prevent fly blow. The navel of calves at time of birth as well as the vulva of fresh cows having a retained afterbirth should be protected from attack.

The maggots of other blowflies may infest the wounds of animals. There are several species of these flies in Puerto Rico but they are of minor importance. The maggots are usually located only in old festering wounds or the young are deposited after a sore has been infested with screw worms. The control is the same as for the screw worms.

Large tail louse of cattle.—The sucking louse (*Haematopinus tuberculatus*) (fig. 2, *H*) is found in colonies in the switch of the tail. On the continent this louse is called the buffalo louse. It is found on the American bison. It is bluish gray in color and large in size in comparison with other lice. The hairs of the switch of the tail may be lined with the nits or ova. Occasionally the eggs are found attached to the hairs on the inside edge of the ears. Heavy infestations are found especially in dairy cows and calves that are confined in stables and corrals. This louse is very common on cattle of the southern coast. If the lice are numerous they abstract considerable blood and lymph from the host and cause itching and irritation and the formation of abrasions and sores.

The official arsenical solutions used for cattle ticks are very effective for eradicating lice. If cattle are sprayed, the switch and end of the tail should be immersed in the solution for a minute or two, as spraying is not as effective in control as dipping. Several dairy-men have reported that this louse can be controlled by using the kerosene-pyrethrum extract sprays. To eradicate lice it is usually necessary to dip or spray at least twice, with an interval of 14 to 16 days between applications, since these preparations cannot be depended upon to kill the eggs. After treatment the stables and pens should be cleaned and disinfected with strong solutions of coal-tar preparations.

Short-nosed ox louse.—A smaller sucking louse, *H. eurysternus*, is sometimes found on imported cattle and heavy infestations are found occasionally on native cattle. This louse is located on the body. Colonies of the lice may be found on the eyelids.

The stable fly.—The stable fly (*Stomoxys calcitrans*) (fig. 2, *K*) is a bloodsucking fly that readily attacks horses and mules, but is also common on cattle. This fly resembles the common house fly, but, among other differences, it has a long slender proboscis, projecting down and forward from the head. The fly deposits its eggs in damp fermenting collections of grass, in cane trash, and in horse or cow manure that contains considerable straw. In the dry areas this

fly is unimportant in cattle in comparison with the hornfly, but in the other areas, at times, it is as common and serious as the hornfly. The treatment is the same as for the hornfly (p. 22). All decaying vegetable material around the stables should be cleaned up every few days and placed with the manure in fly-tight bins or pits.

Mosquitoes.—Various species of mosquitoes attack animals, especially horses and cattle. The actual damage caused by them is not known, but it may be considerable where mosquitoes are numerous. Investigators connected with the Bureau of Malaria Control of Puerto Rico have found by actual count that the two species of mosquitoes transmitting malaria show rather a decided preference for feeding upon horses and cattle as compared with man. No practical method has been found for protecting livestock from mosquitoes. Destroying the breeding places by drainage or treatment with oil or paris green or by impounding water and using certain species of small fish which eat the wrigglers or larvae are always important control measures for mosquitoes.

Fleas.—Occasionally fleas attack young stock which are confined, in sufficient numbers to cause considerable irritation and a loss in condition. These pests can be controlled by spraying with kerosene or with the kerosene-pyrethrum extract sprays. First cleaning up the litter and then spraying the floors and walls of the stable with kerosene are also important control measures.

The leeches or "sanguijuelas."—The leeches (fig. 2, *J*) should be mentioned as occasional parasites of some importance. They are very abundant in swampy land. They attach themselves to any part of the body of the host animal which they can reach, while the animal is standing in water, and occasionally enter the mouth or nostril while the animal is drinking.

Leeches not only suck considerable blood, increasing enormously in size, but make wounds from which there is some hemorrhage after the engorged leeches become detached. Leeches can be destroyed by treating the water with copper sulphate, as described for the snail transmitting the liver fluke.

Poisonous arthropods.—According to the unpublished statement of one authority,⁴ there are a number of arthropods reputed to be poisonous, among which may be mentioned the so-called tarantulas of the family Avicularidae; large centipedes; several species of scorpions; and at least one species of whip scorpion known locally as the "guavá." The "guavá" is probably the most dangerous of the group. Owing to lack of scientific investigations it is impossible to make any definite statements as to the exact degree of their venomous qualities. However, there is little or no direct evidence that the poisonous arthropods in Puerto Rico, except for occasional and unimportant injuries, are dangerous to cattle or other animals.

Exotic parasites.—Both external and internal parasites have been found in imported cattle. Among these, the cattle grubs, *Hypoderma* spp., the larvae of warble flies, are common and conspicuous. Small tumors or lumps are found in the skin of the back, which contain the larvae (fig. 2, *G*). There is no authentic record of these flies having reproduced themselves in this climate.

⁴ Stuart Danforth, professor of zoology, University of Puerto Rico.

ERADICATION OF PARASITES

The only effective means of control of some of the diseases and parasites is by island-wide eradication campaigns. Such campaigns are comparatively simple because Puerto Rico is an island and the territory to be covered is small. The cattle tick and liver fluke are two serious parasites that should be eradicated at this time. In the United States the eradication of the cattle tick is being accomplished by proper dipping of all cattle and horses in a given area, at 14-day intervals over a period of 9 months. The State of California has completed a campaign of eradication of the liver fluke in sheep by destroying the snail which transmits the parasite. Puerto Rico needs more and better livestock and a larger and better dairy industry, and these objects can be promoted greatly by eradication of the tick and liver fluke.

